

## Revision of Cassiduloid genus *Gongrochanus* Kier (Echinodermata: Echinoidea) from South Indian Cretaceous deposits

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**Abstract.** Revision of the genus *Gongrochanus* Kier from Upper Cretaceous beds of South India has revealed the presence of seven species including its type species *G. herschelianus* (M'Clelland). On the basis of phyllode characters the species have been divided into two informal groups. A biometrical analysis by applying the Bartlett's and *F*-test proves the validity of the species described. Coefficients of correlation and regression computed for parameters of length, width and height for *G. herschelianus* are dependent upon one another; that change of length versus width is more regular than that of length versus height. Occurrence of this genus in *Hauriceras rembda* zone and *Pachydiscus otacodensis* zone of Kallankurichchi and Ottakkovil formations respectively of Ariyalur Group helps in rectifying its geological age which now can be taken as extending from Lower Maestrichtian to Middle Maestrichtian instead of Senonian.

**Keywords.** *Gongrochanus*; Cassiduloid; geological range; Maestrichtian; Cretaceous deposits; Echinoidea

### 1. Introduction

Specimens of *Gongrochanus* collected by M'Clelland (1840) from friable grey sandstones and associated yellow clays and limestones of the Cretaceous age around Cherrapunji (25°-15', 91°-44') were placed by him under a new genus *Cyrtoma* describing seven species. Forbes (1846) placed similar specimens from South Indian Cretaceous deposits under *Nucleolites* Lamarck which were subsequently transferred by Stoliczka (1873) to *Stigmatopygus* d'Orb. Since then, while referring to those specimens from Cherrapunji and South India, the name *Stigmatopygus* has been used by many workers like Kossmat (1897), Matley (1929), Spengler (1923), Sastry and Mamgain (1971), Dutta (1974), Bhattacharya and Bhattacharya (1978) and Das *et al* (1981). Only Das Gupta (1920) opined that these specimens differ from *Stigmatopygus* and should be retained under *Cyrtoma* of M'Clelland.

Kier (1962, 1966) in his revision of Cassiduloids proposed a new generic name *Gongrochanus* with *G. herschelianus* (M'Clelland) as its type species; as *Cyrtoma* was pre-occupied in order Diptera (Insecta). Kier (1962, 1966) erroneously designated lectotype for *Gongrochanus herschelianus* (M'Clelland) from Forbes' material (now in British Museum) from South India, whereas a lectotype can only be selected from the original type series of M'Clelland's material. Since efforts to trace the latter material proved in vain, a neotype needs to be established for this otherwise valid species, our material agrees fairly with the redescription of Forbes' material by Kier (1962, 1966).

Therefore, the present authors are getting in touch with Dr Kier, and together designated the neotype and neoparatypes in due course, presuming M'Clelland's material is lost.

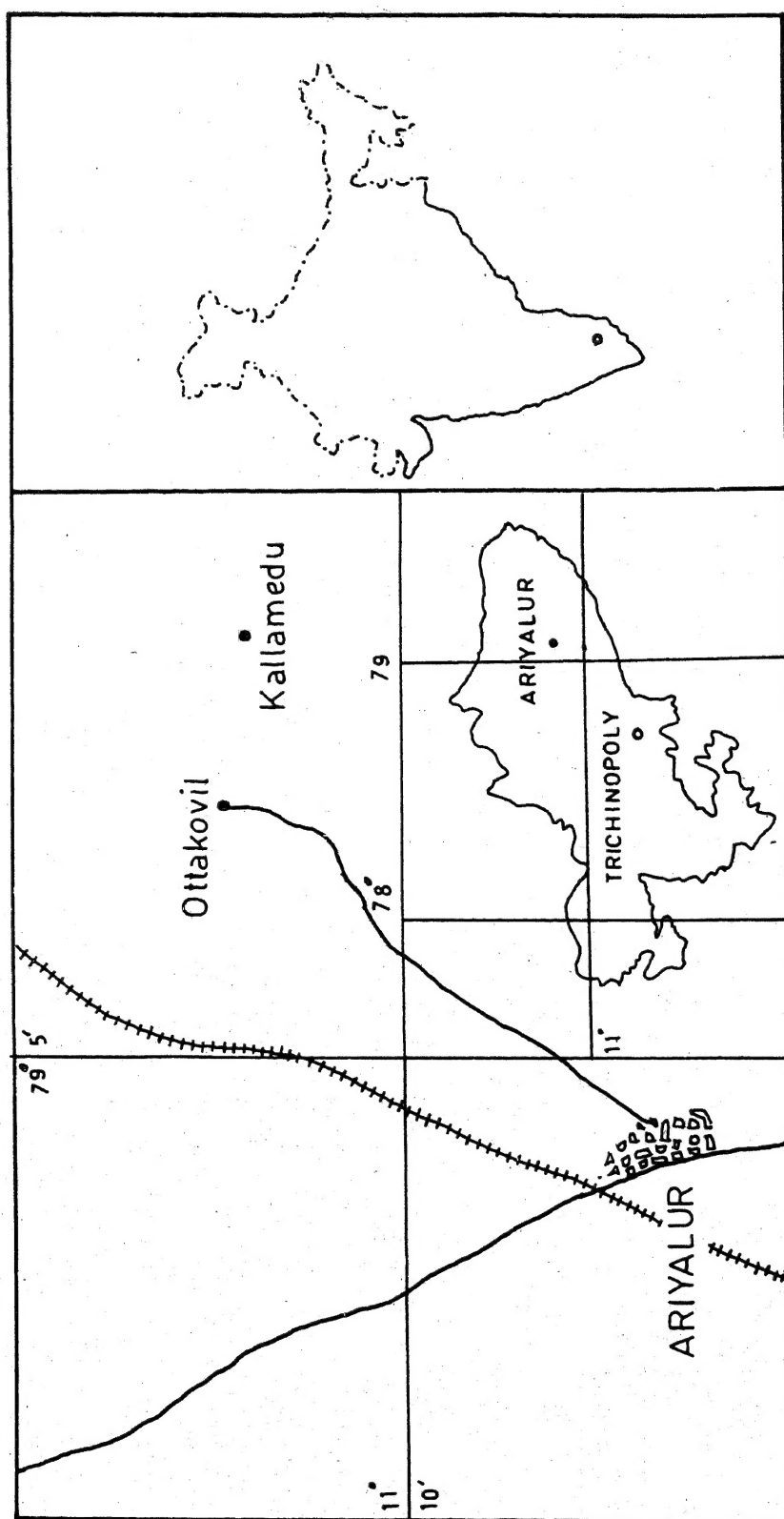


Figure 1. Locality Map.

Out of seven species described by M' Clelland (1840) only *G. herschelianus* has been recognised by Kier (1962, 1966) and Kier and Lawson (1978); and the other names have not been referred to for more than 140 years. Also figures and descriptions given by M' Clelland are far from being adequate for any comparison. Hence, we propose these names be treated as *nomen dubia* and need be rejected as *nomen oblita* (forgotten names) under article 78 (f) of ICZN (1964).

A rich collection of the members of this genus made by us from the Ottakovil area ( $11^{\circ} 11'$ ;  $79^{\circ} 07'$ ) (figure 1) of the South Indian Cretaceous deposits, shows considerable morphological variations warranting a revision. While erecting species more stress is given on variations found in petaloid and phyllode areas which may have direct bearing on the internal anatomy of the soft parts.

The phyllode pattern is characteristically pygurid with two distinctive arrangements of pores from the middle zone. On this basis, two informal groups *viz.* *Herschelianus* and *Ottakovilensis* groups have been proposed. In the former group pores from middle zone are scattered, while in the latter group they are aligned to form a single row (figure 2).

## 2. Systematic description

|        |                                  |
|--------|----------------------------------|
| Phylum | : Echinodermata                  |
| Class  | : Echinoidea                     |
| Order  | : Cassiduloida Claus, 1880       |
| Family | : Fijasidae Lambert, 1905        |
| Genus  | : <i>Gongrochanus</i> Kier, 1962 |

### 2.1 *Herschelianus* Group: Scattered pores in middle zone.

#### 2.1 a. *Gongrochanus herschelianus* (M' Clelland) (figure 3a-c)

1840 *Cyrtoma herscheliana* M' Clelland, p. 185-187, pl. 5, figure 1-3.

1846 *Nucleolites elatus* Forbes: Forbes, p. 162, pl. 19, figure 1.

1873 *Stigmatopygus elatus* (Forbes): Stoliczka, p. 28, pl. 5, figure 5a-d, non 1-4 and 6, 7, 8.

1920 *Cyrtoma herscheliana* M' Clelland: Das Gupta p. 296.

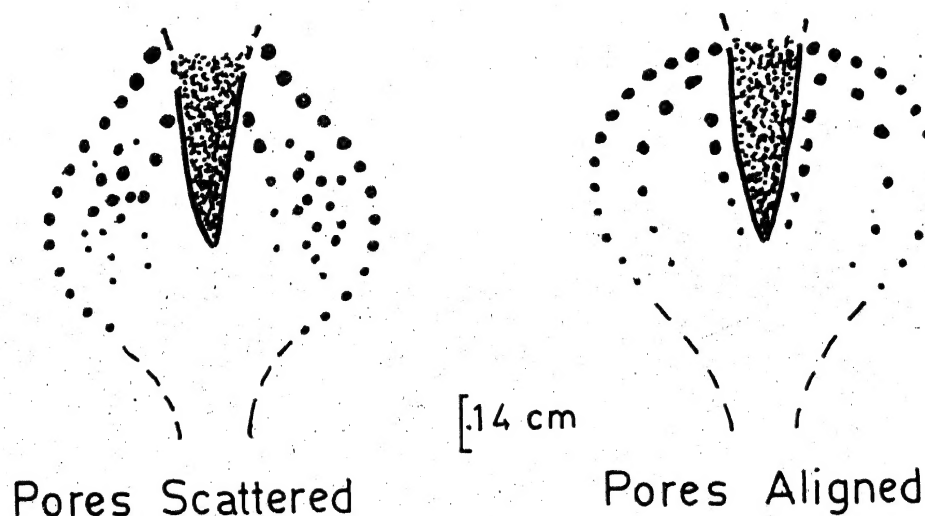


Figure 2. Phyllode patterns.

1923 *Stigmatopygus elatus* (Forbes): Spengler p. 5-7, pl. 1, figures 3a, b.

1962 *Gongrochanus herscheliana* (M'Clelland): Kier, p. 131, pl. 19, figures 4-6, pl. 20, figure 1, text figures 118.

1966 *Gongrochanus herschelianus* (M'Clelland): Kier, P.U. 512, figure 399. 4a-c.

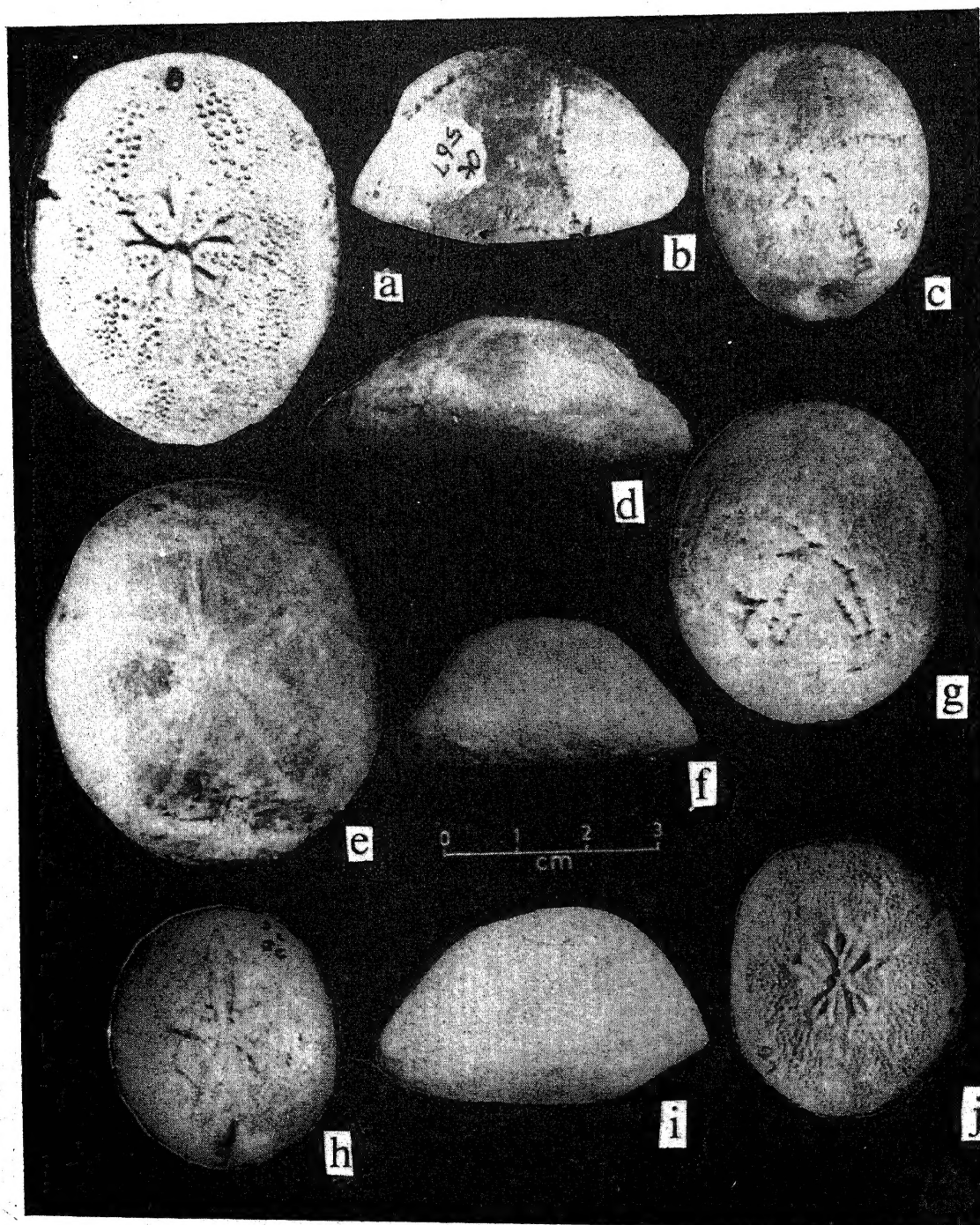


Figure 3. Species of *Herschelianus* group a-c. *G. herschelianus* (M'Clelland) figured specimen No. MACSG 1393 a. oral view b. lateral view c. aboral view d-e. *G. chiplonkari* sp. nov. Holotype No. MACSG 1439 d. lateral view e. aboral view; f, g and j *G. stoliczkai* sp. nov. Holotype No. MACSG 1448 f. lateral view g. aboral view j. oral view h, i. *G. kieri* sp. nov. Holotype No. MACSG 1457 h. aboral view i. lateral view.

1978 *Stigmatopygus elatus* (Forbes): Bhattacharya and Bhattacharya, pl. 4; figures 1-3.

**Material:** 50 Specimens figured specimen no. MACSG 1393 other numbers 1392, 1394 to 1438.

**Table 1.** Range of number of pores on Ambulacra.

| Species                     | I     | II    | III   | IV    | V     |
|-----------------------------|-------|-------|-------|-------|-------|
| <i>Herschelianus</i> Group  |       |       |       |       |       |
| <i>G. herschelianus</i>     | 23-24 | 23-24 | 30-33 | 20-23 | 24-25 |
| <i>G. chiplonkari</i>       | 32-36 | 30-32 | 48-50 | 32-35 | 30-32 |
| <i>G. stoliczkai</i>        | 33-35 | 30-32 | 38-40 | 30-32 | 32-35 |
| <i>G. kieri</i>             | 28-30 | 28-30 | 56-60 | 30-32 | 32-36 |
| <i>Ottakovilensis</i> Group |       |       |       |       |       |
| <i>G. Ottakovilensis</i>    | 23-24 | 27-38 | 35-37 | 28-30 | 23-24 |
| <i>G. circularis</i>        | 26-28 | 28-30 | 45-50 | 30-32 | 28-30 |
| <i>G. tamilnaduensis</i>    | 30-32 | 25-28 | 40-42 | 25-28 | 30-32 |

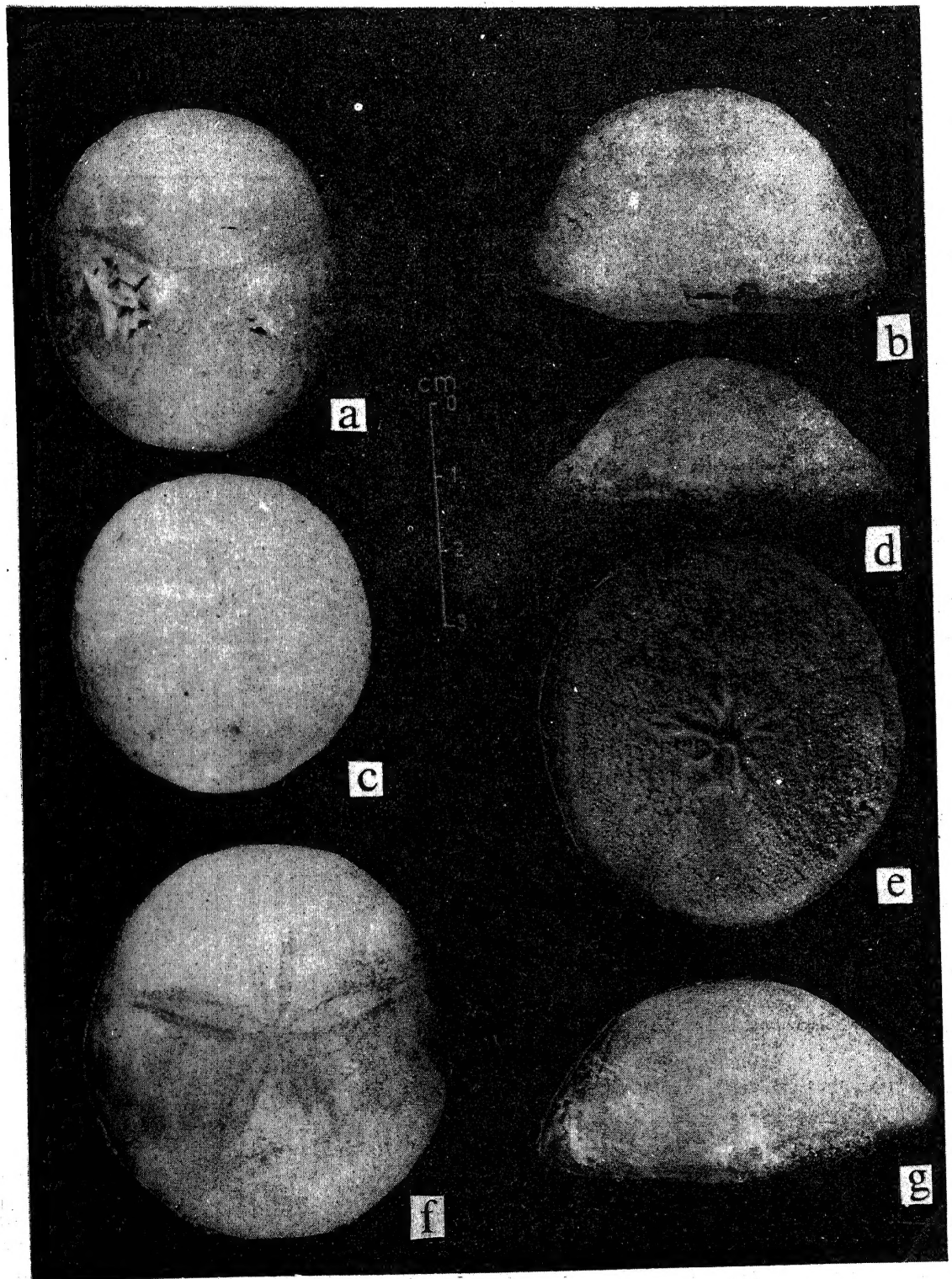
**Table 2.** Range of number of pores on phyllode areas.

| Species                     | Outer row | Middle row | Inner row |
|-----------------------------|-----------|------------|-----------|
| <i>Herschelianus</i> Group  |           |            |           |
| <i>G. herschelianus</i>     | 10-13     | 04-07      | 04-05     |
| <i>G. chiplonkari</i>       | 09-12     | 15-17      | 08-10     |
| <i>G. stoliczkai</i>        | 18-20     | 08-10      | 10-12     |
| <i>G. kieri</i>             | 17-20     | 06-08      | 10-12     |
| <i>Ottakovilensis</i> Group |           |            |           |
| <i>G. Ottakovilensis</i>    | 09-13     | 05-06      | 04-06     |
| <i>G. circularis</i>        | 10-17     | 08-10      | 08-12     |
| <i>G. tamilnaduensis</i>    | 18-20     | 06-08      | 10-12     |

Dimensions: (in cm)

| Sp. No.    | L   | W   | H   | L/W  | L/H  |
|------------|-----|-----|-----|------|------|
| MACSG 1392 | 5.1 | 4.5 | 2.8 | 1.13 | 1.82 |
| MACSG 1393 | 5.3 | 4.5 | 2.6 | 1.17 | 2.03 |
| MACSG 1394 | 5.0 | 4.0 | 2.5 | 1.25 | 2.00 |
| MACSG 1395 | 4.8 | 3.8 | 1.8 | 1.26 | 2.66 |
| MACSG 1438 | 4.4 | 3.5 | 2.2 | 1.25 | 2.00 |

**Description:** Test low with distinctly pentagonal ambitus, anteriorly round and posteriorly drawn out. Maximum width at 3/4th the length from anterior, posterior slope steeper than anterior, summit at 3/5th the length from anterior.



**Figure 4.** Species of *Ottakovilensis* group. **a, b.** *G. Ottakovilensis* sp. nov. Holotype No. MACSG 1467 **a.** oral view **b.** lateral view **c-e.** *G. circularis* sp. nov. **c.** Holotype No. MACSG 1477, aboral view **d.** Paratype No. MACSG 1478, lateral view **e.** Paratype No. MACSG 1478, oral view **f, g.** *G. tamilnaduensis* sp. nov. Holotype No. MACSG 1487 **f.** aboral view **g.** lateral view.

Ambulacral areas petaloid with 30-33 pores in III ambulacrum (refer table 1 for number of pores on other ambulacra), phyllode pores in three rows, outer slit-like and sinuous along phyllode termination, middle row with scattered round pores and inner row rather straight with only four to five round pores (see table 2 for details of phyllode pores in each species).

**Remarks:** This species is represented in our collection by a large number of specimens which agree well with figures of *G. herschelianus* given by Kier (1962, 1966). Neotype and neoparatypes will be designated in consultation with Dr Kier since he inadvertently designated lectotype from material other than M'Clelland.

2.1 b *Gongrochanus chiplonkari* n. sp. (figure 3 d, e)

**Material:** 9 specimens; *Holotype* no. MACSG 1439; *Paratype* nos. MACSG 1440 to 1447.

Dimensions: (in cm)

| Sp. No.    | L   | W   | H    | L/W  | L/H   |
|------------|-----|-----|------|------|-------|
| MACSG 1439 | 5.7 | 4.9 | 2.1  | 1.16 | 2.71  |
| MACSG 1440 | 5.8 | 5.5 | 2.95 | 1.05 | 1.966 |
| MACSG 1447 | 5.5 | 4.5 | 2.3  | 1.22 | 2.39  |

**Description:** Test flattened, low with pentagonal ambitus, adoral surface highly concave. Anterior and posterior slopes nearly equal; summit at half the length from posterior, maximum width in the middle.

III ambulacrum with 48-50 pores; phyllode pores in three rows, outer slit like, sinuous, and 9-12 in number, middle row with scattered pores 15-17 and inner row with 8-10 pores in straight line.

**Remarks:** This species has low test with highly depressed adoral surface as in *G. stoliczkai*, but the latter has adoral concavity less pronounced, with elliptical outline and summit anterior to the centre, anterior slope steeper than posterior, also petaloid and phyllode pores more in number.

**Etymology:** The species is named after Prof. G W Chiplonkar for his significant contributions to the Cretaceous Palaeontology of India.

2.1 c *Gongrochanus stoliczkai* n. sp. (figure 3f, g-j)

**Material:** 9 specimens; *Holotype* no. MACSG 1448; *Paratype* nos. 1449 to 1456.

Dimensions: (in cm)

| Sp. No.    | L   | W   | H   | L/W  | L/H  |
|------------|-----|-----|-----|------|------|
| MACSG 1448 | 5.0 | 4.2 | 2.2 | 1.19 | 2.27 |
| MACSG 1449 | 4.1 | 4.0 | 2.3 | 1.02 | 1.78 |
| MACSG 1450 | 4.6 | 3.9 | 2.3 | 1.17 | 2.00 |
| MACSG 1456 | 5.0 | 4.6 | 2.2 | 1.08 | 2.27 |

**Description:** Test low with elliptical outline, anterior broadly round, posteriorly slightly protruding, anterior slope steep, posterior gentle, the maximum

width at  $1/3$ rd the distance from posterior, summit slightly anterior to centre, adoral surface concave. III ambulacrum with 38-40 pores, 18-20 pores in outer row of phyllode area, middle scattered pores 08-10 in number while the inner row with 10-12 pores.

**Remarks:** In outline this species appears very close to *G. kieri*, but the latter has flat adoral surface; and much larger number of pores i.e. 50-60 in III ambulacrum.

**Etymology:** Named after Dr F Stoliczka who did pioneering work in Indian Palaeontology.

2.1d. *Gongrochanus kieri* n. sp. (figure 3h, i)

**Material:** 10 specimens; *Holotype* no. MACSG 1457; *Paratype* nos. MACSG 1458 to 1466.

**Dimensions:** (in cm)

| Sp. No.    | L   | W   | H   | L/W  | L/H  |
|------------|-----|-----|-----|------|------|
| MACSG 1457 | 5.1 | 4.2 | 2.1 | 1.21 | 2.4  |
| MACSG 1458 | 4.9 | 4.0 | 2.0 | 1.22 | 2.4  |
| MACSG 1466 | 4.4 | 3.7 | 2.1 | 1.18 | 2.09 |

**Description:** Test low, outline elliptical tapering anteriorly and broad at the posterior, maximum width at  $1/3$ rd the length from the posterior, summit in the middle, adoral surface flat, pores in III ambulacrum 56-60. Phyllode area outer zone with 18-20 pores, middle scattered pores 08-10 in number, while the inner row with 10-12 pores.

**Remarks:** This species resembles close to *G. stoliczkai*, but can be differentiated on the points stated under *G. stoliczkai* (*vide supra*). Another species which can be easily confused with the present species is *G. tamilnaduensis* (*vide infra*) but the pattern of phyllode area in *G. tamilnaduensis* is, however, different, i.e. having aligned pores in the middle zone (see details under *Ottakovilensis*) group (*vide infra*).

**Etymology:** It is named after Dr P M Kier of Smithsonian Institute, U.S.A.

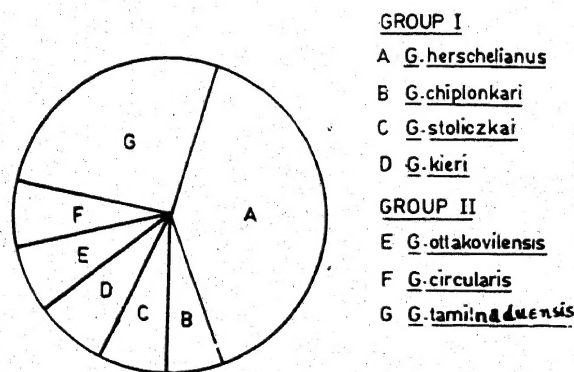


Figure 5.  $\pi$ -diagram showing population of erected species.

**2.2 *Ottakovilensis* Group :**

Aligned pores in the middle zone. This informal group comprises three species viz., *Gongrochanus ottakovilensis*, *G. tamilnaduensis* and *G. circularis*.

**2.2a. *Gongrochanus ottakovilensis* n. sp. (figure 4a, b)**

**Material:** 12 specimens: *holotype* no. MACSG 1467. *Paratype* nos. 1468 to 1478.

**Dimensions:** (in cm)

| Sp. No.    | L   | W   | H   | L/W  | L/H  |
|------------|-----|-----|-----|------|------|
| MACSG 1467 | 5.5 | 4.1 | 3.1 | 1.34 | 1.77 |
| MACSG 1458 | 3.6 | 3.1 | 2.5 | 1.16 | 1.44 |
| MACSG 1478 | 6.0 | 4.6 | 3.2 | 1.30 | 1.87 |

**Description:** Test tall, elliptical with sides parallel, anteriorly obtusely round, posteriorly slightly drawn. Maximum width in the middle and summit in the centre, posterior slope steeper than anterior. Number of pores on ambulacrum III 35-37 and phyllode pores in three distinct rows, outer ones with 09-13 pores, middle parallel to outer ones and 05-06 in number, the inner ones 04-06 in number forming a straight line.

**Remarks:** This species can be separated from its two allies i.e. *G. circularis* and *G. tamilnaduensis* by its tall test, and less number of ambulacral pores in ambulacrum III, and in outer zone of phyllode area.

**Etymology:** It is named after the locality.

**2.2b. *Gongrochanus circularis* n. sp. (figure 4c, d, e)**

**Material:** 10 specimens; *Holotype* no. MACSG 1477. *Paratype* nos. 1478 to 1486.

**Dimensions:** (in cm)

| Sp. No.    | L   | W   | H   | L/W  | L/H  |
|------------|-----|-----|-----|------|------|
| MACSG 1477 | 4.4 | 3.7 | 2.1 | 1.18 | 2.09 |
| MACSG 1478 | 5.0 | 4.6 | 2.3 | 1.08 | 2.17 |
| MACSG 1479 | 5.0 | 4.5 | 2.1 | 1.11 | 2.38 |
| MACSG 1486 | 3.9 | 3.7 | 2.0 | 1.05 | 1.95 |

**Description:** Test low, ambitus circular, posterior margin sometimes insignificantly drawn out; adoral surface flat, ambulacral areas distinctly raised above the general surface; summit centrally situated. Number of pores in III ambulacrum 45-50, phyllode pores typical of group II being in three zones. Outer zone with 10-17 pores, middle with 08-10 pores and inner with 8-12 pores.

**Remarks:** Since it is circular in outline, with adoral surface flat and centrally placed summit, it has discoidal appearance and ambulacral areas distinctly raised above the general surface.

**Etymology:** The name is derived from the circular ambitus, a characteristic feature of this species.

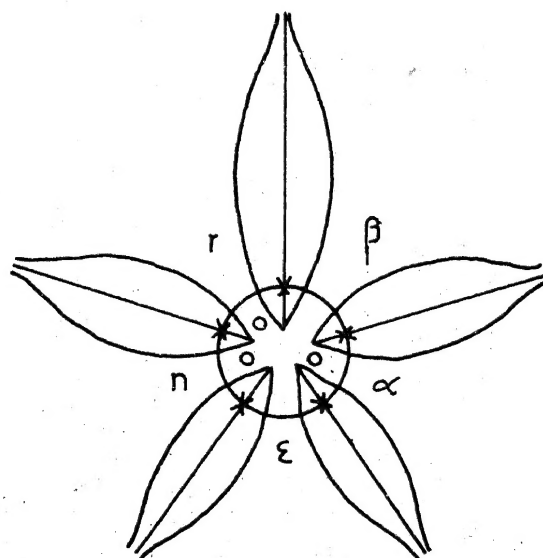


Figure 6. Schematic representation of interpetaloid angles.

2.2c. *Gongrochanus tamilnaduensis* n. sp. (figure 4f, g)

**Material:** 42 specimens; Holotype no. MACSG 1487. *Paratype* nos. 1488 to 1528.

Dimensions: (in cm)

| Sp. No.    | L   | W   | H   | L/W  | L/H  |
|------------|-----|-----|-----|------|------|
| MACSG 1487 | 5.8 | 4.8 | 2.6 | 1.20 | 2.23 |
| MACSG 1488 | 5.0 | 4.3 | 1.7 | 1.16 | 2.94 |
| MACSG 1489 | 5.3 | 4.4 | 2.4 | 1.20 | 2.20 |
| MACSG 1528 | 5.2 | 4.7 | 2.4 | 1.10 | 2.16 |

**Description:** Test medium in height, sub-pentagonal to pentagonal in outline, anterior side with a gentle slope than the posterior; maximum width at half the length and nearly central summit. Adoral surface flat. Number of pores in ambulacrum III 40-42, phyllode outer zone sinuous with 18-20 pores, middle zone with 06-08 pores and inner zone with 10-12 pores.

**Remarks:** This species differs from *G. circularis* in having pentagonal outline, while it has higher  $L/H$  ratio as compared to *G. ottakovilensis*.

**Etymology:** It is named after the state of Tamilnadu in which these fossils occur.

2.3 *Locality and horizon*

All the species described above come from gray to white coarse grained calcareous sandstones of Ottakovil Formation of Ariyalur Group exposed east of Ottakovil.

3. Discussion

3.1 *Comparison with Stigmatopygus*

*Gongrochanus* can easily be distinguished from *Stigmatopygus* by its supramarginal periproct situated in a longitudinal groove and presence of a prominent

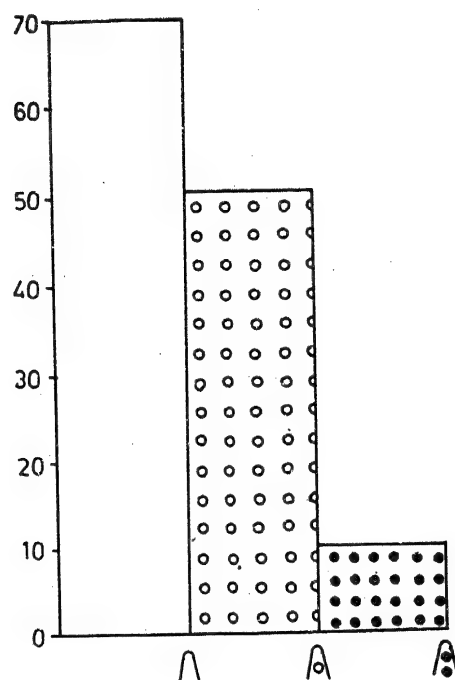


Figure 7. Variation of tuberculation on V tooth.

bulge on the median area of each phyllode. Kier (1962 p. 132) states, "Striking feature in *Gongrochanus herscheliani* is prominent bulge in the median area of each phyllode. This feature is not present on any of the species of *Stigmatopygus* or as far as I know in any other echinoid"

### 3.2 Petaloid pores (table 1)

Pores in petaloid region vary in number in individual specimens, but can be grouped by fixing certain limits and it has been found that this grouping when taken with other features helps to identify the species.

### 3.3 Phyllode pores (table 2)

The set of pores developed in the phyllode area appears more significant at generic level (Kier 1962, 1966).

A careful study of population of the species described here reveals that larger number of specimens fall in *Herschelianus* group than in *Ottakovilensis* group (figure 5).

The evolutionary trend of pygurid phyllode may be towards that of *Ottakovilensis* group, where there is reduction in the number of pores, accompanied by their alignment.

A critical study of three hundred and odd specimens belonging to this genus, with a view to find out a basis of classification of the species described here has revealed the pattern of pores in the phyllodes; according to which, these species could be placed in two informal groups, *Herschelianus* and *Ottakovilensis*.

### 3.4 Ambital geometry and nature of adoral surface

Further speciation can be made on the characters like outline of the ambitus, nature of adoral surface and interambulacral angles, etc.

Most of the specimens described here generally have pentagonal to oval outline at ambitus, but *G. circularis* is characterised by a distinctly circular outline.

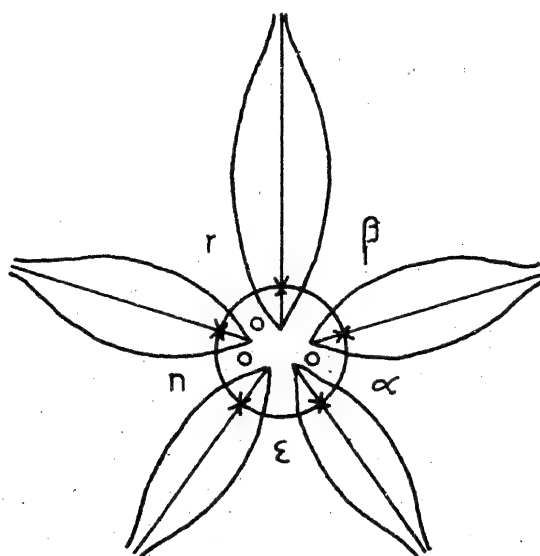


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| Sp. No.    | L   | W   | H   | L/W  | L/H  |
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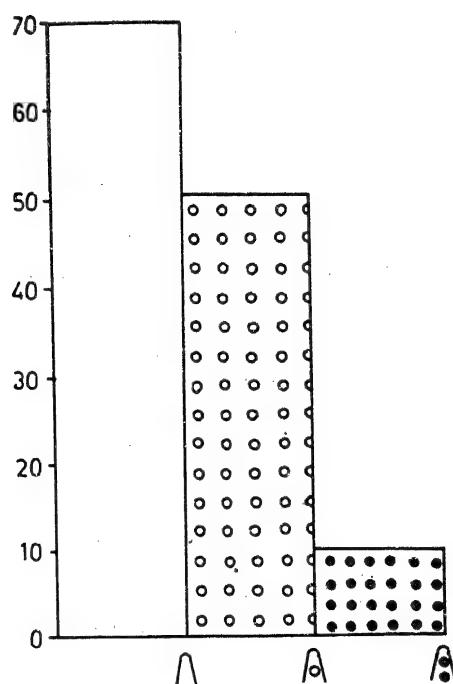


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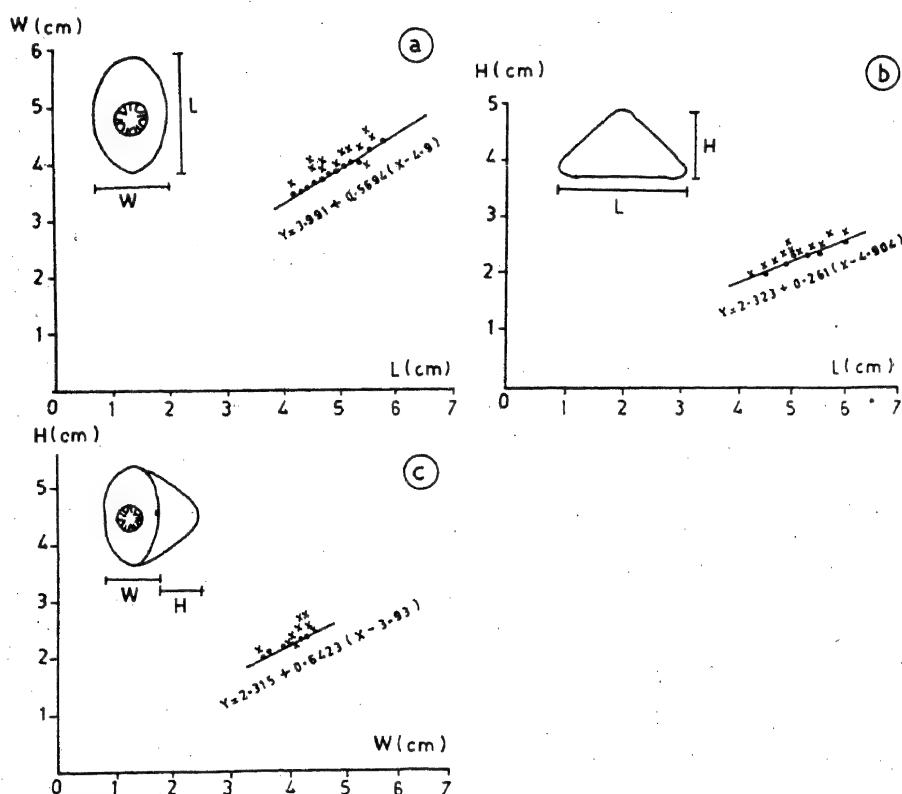


Figure 8. Regression lines of morphometric parameters a. width on lengths b. height on length c. height on width.

*G. chiplonkari* and *G. stoliczkai* have their oral surface depressed thus differing from other species. This feature cannot be considered as just a variation, but appears to have an evolutionary significance since it must have affected the internal anatomy of the animals, also consequent to the external build.

### 3.5 Ambulacral angles

As conceived from figure 6 and table 3 species may have variable interpetaloid angles without any pattern which cannot be linked up with *L*, *W* and *H*. Thus *G. chiplonkari* and *G. stoliczkai* though appear almost identical in external morphology including concave oral surface have their posterior inter-petaloid angle ( $\epsilon$ ) highly distinctive and can be isolated by visual examination.

### 3.6 Tuberculation

One more variation which needs attention is tuberculation on the fifth tooth. On the other four teeth, the number and arrangement of tubercles are fairly constant, but on the fifth tooth three variations have been noticed, irrespective of the species and growth stage (figure 7). In some specimens, the area of the fifth tooth is completely naked; some have only one tubercle at the distal end while some are with two or more tubercles, covering the entire surface of the tooth. Observations made on about 130 specimens reveal that the frequency of the naked tooth is highest. The advantage or disadvantage of the absence or presence of spines on the fifth tooth is not yet sufficiently understood.

## 4. Age

The specimens of *Gongrochanus* described here come from the Ottakovil Formation of Ariyalur Group. Recently a few specimens of this genus have also

Table 3. Interpetaloid angles (in degrees).

| Species                     | $\alpha$ | $\beta$ | $\gamma$ | $\eta$ | $\epsilon$ |
|-----------------------------|----------|---------|----------|--------|------------|
| <i>Herschelianus</i> Group  |          |         |          |        |            |
| <i>G. herschelianus</i>     | 58-60    | 89-91   | 89-90    | 47-49  | 69-70      |
| <i>G. chiplonkari</i>       | 78-80    | 52-53   | 91-93    | 72-75  | 61-63      |
| <i>G. stoliczkai</i>        | 68-70    | 79-83   | 75-77    | 89-92  | 40-42      |
| <i>G. kieri</i>             | 77-79    | 80-82   | 80-81    | 67-70  | 52-55      |
| <i>Ottakovilensis</i> Group |          |         |          |        |            |
| <i>G. Ottakovilensis</i>    | 90-93    | 60-63   | 47-50    | 89-90  | 50-53      |
| <i>G. circularis</i>        | 62-66    | 78-80   | 58-60    | 90-94  | 58-60      |
| <i>G. tamilnaduensis</i>    | 80-82    | 70-74   | 68-70    | 76-78  | 54-56      |

Table 4. Bartlett's test for the genus *Gongrochanus*.

| Morphometric parameter | $\chi^2$ with six degree of freedom | Table values of six degrees of freedom at 0.05 probability |
|------------------------|-------------------------------------|--|
| Length                 | 1.2674086                           | 12.59  |
| Width                  | 1.99997665                          | 12.59  |
| Height                 | 2.7721758                           | 12.59  |

Table 5. F-Test for the genus *Gongrochanus*.

| Morphometric parameter | Degrees of freedom | Table value at 0.05 probability | Calculated value | Inference  |
|------------------------|--------------------|---------------------------------|------------------|--|
| Length                 | F <sup>6</sup> 141 | 3.7                             | 4.9933094        | Means of morphometric parameters are 99% significantly different |
| Width                  | F <sup>6</sup> 145 | 3.7                             | 6.5846112        |  |
| Height                 | F <sup>6</sup> 145 | 3.7                             | 4.03476673       |  |

Table 6. Co-efficient of correlation ( $r$ ) and regression: ( $b$ ) computed for different combinations of morphometric parameters of *G. herschelianus*.

| Combinations of morphometric parameters | $r$        | $b$          |
|---|------------|--------------|
| Length <i>vs</i> width                  | 0.85192977 | 0.569431399  |
| Length <i>vs</i> height                 | 0.56013788 | 0.261080092  |
| Width <i>vs</i> height                  | 0.80424293 | 0.0642350795 |

been collected from the Kallankurichchi Formation of the same Group from near Kallankurichchi. Sastry *et al* (1968, 1972) have considered these two formations to range from Lower Maestrichtian to Middle Maestrichtian on the basis of *Hauriceras rembda* zone and *Pachydiscus otacodensis* zone.

The original specimens of this genus reported by M'Clelland (1840) were from Assam Cretaceous deposits. Bhattacharya and Bhattacharya (1978) made a fresh

collection from these areas and reported specimens of *Gongrochanus* as *Stigmatopygus elatus* proposing a new zone *Anisoceras* – *Stigmatopygus* assemblage zone within the Mahadek Formation. The Mahadek Formation ranges in age, from Campanian to upper Maestrichtian (Bhattacharya and Bhattacharya *op cit.*). However, they have not given the precise age of *Anisoceras* – *Stigmatopygus* zone which is developed in the upper part of Mahadek Formation. Hence in the light of a firm evidence obtained from biostratigraphic zonations of South Indian Cretaceous deposits the genus *Gongrochanus* ranges from Lower Maestrichtian to Middle Maestrichtian. Thus, the Senonian age proposed by Kier (1962, 1966) and Kier and Lawson (1968) needs a rectification as above. It may be mentioned here that the genus *Stigmatopygus* d'Orbigny *Sensu stricto* is so far known to occur in Europe and Africa (Kier 1962, 1966; Kier and Lawson 1978). As against that the *Gongrochanus* is restricted only to Indian sub-continent being reported from Kallankurichchi and Ottakovil Formations from South Indian Cretaceous deposits in Tamilnadu and the Mahadek Formation from Meghalaya. Since the genus *Stigmatopygus* is not known to occur in India, all the specimens described under it are infact of *Gongrochanus* Kier. Consequently *Anisoceras* – *Stigmatopygus* assemblage zone of Bhattacharya and Bhattacharya (1978) has to be redesignated as *Anisoceras* – *Gongrochanus* assemblage zone and precise age of it will have to be established after a critical study of the fauna of this zone.

## 5. Key

Following is the key to identify species of *Gongrochanus*.

1. Phyllode area with middle zone having scattered pores
    - Informal *Herschelianus* group
    - G. herschelianus*,
    - G. kieri*, *G. stoliczkai*,
    - G. chiplonkari*
  1. Phyllode area with middle zone having aligned pores
    - Informal *Ottakovilensis* group
    - G. Ottakovilensis*,
    - G. tamilnaduensis*,
    - G. circularis*
- 5.1 Informal *Herschelianus* Group
1. Test tall
    - G. herschelianus*
  1. Test dwarf
    - 2. Adroally plane
      - G. kieri*
    - 2. Adroally concave
      - G. chiplonkari*
      - G. stoliczkai*
    - 3. Posterior ambulacral angle of divergence narrow ( $40^{\circ}$ – $42^{\circ}$ )
      - G. stoliczkai*
    - 3. Posterior ambulacral angle of divergence broad ( $61^{\circ}$ – $63^{\circ}$ ).
      - G. chiplonkari*
- 5.2 Informal *Ottakovilensis* Group
1. Test circular
    - G. circularis*
  1. Test not circular

2. Phyllode pore in outer zone more
2. Phyllode pore in outer zone less

*G. tamilnaduensis*  
*G. Ottakovilensis*

## 6. Biometrics

All the seven species described here come from the same locality and horizon representing a heavy fossil population of *Gongrochanus*. A casual inspection of six hundred and odd specimens collected systematically revealed that this population is highly diversified, and it would not be proper to place them under a single species. With a careful examination of various morphological parameters seven species have been recognized as given in the key. Further to strengthen the validity of these species two important biometric tests have been applied. These are Bartlett's and *F*-tests (Woolf 1968; Freneix 1979). By Bartlett's test (table 4) homogeneity of variances of these species is tested. The morphometric parameters *viz.* length, width and height have been chosen for this test.

It has been found that Chi-square is sufficiently less than the table values and hence its null hypothesis of homogeneous variances is accepted. Thus the new species maintain their entity.

The second test applied is the *F*-test (table 5) by using the same parameters of length, width and height. The null hypothesis assumes that the species have similar means of their morphometric parameters. Contrary to this assumption the test shown higher values than the table values, rejecting the null hypothesis. This again proves the validity of being the new species.

The coefficients of correlation and regression are computed for the different combinations of morphometric parameters of *G. herschelianus* (table 6). It indicates that the changes of *L*, *W*, and *H* are dependent upon one another and the change of length versus width is more regular than that of length versus height (figures 8 a,b) and the change of width versus height is more akin to that of length versus width (figure 8c).

Recently, Das *et al* (1981) have made a morphometric study of *Stigmatopygus elatus* (Forbes) (now *G. herschelianus*). In using this taxonomic designation they have evidently overlooked or are unaware of the taxonomically decisive significance of phyllode and petaloid areas. Similarly, specimens described by McClelland (1840), and Bhattacharya and Bhattacharya (1978) as *Cyrtoma* and *Stigmatopygus elatus* (Forbes) respectively belong to *Gongrochanus*. Hence even in the absence of characters of oral region the specimens of Das *et al* can be placed under *Gongrochanus*.

Before adopting any statistical approach due attention should be given to the characters which are diagnostic at generic level. In the case of *Gongrochanus* teeth like bulges on phyllode areas are unique feature peculiar to this genus. The other character which may not be morphometrically important, but genetically diagnostic is the alignment of pores on phyllode area which helped us to split the South Indian specimens of this genus into two informal groups. Thus, it will be worthwhile in first ascertaining all such features to decide correct taxonomic position and before subjecting any material to desired statistical exercises, otherwise it will result in faulty exercises due to wrong evaluation of characters of biological significance.

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